

REDOUBT UNIT AND WEST MCARTHUR RIVER UNIT UIC FACT SHEET

Proposed Issuance of Underground Injection Control (UIC) Permit AK-11007-A
for the Operation of Two Class I Non-Hazardous Industrial Waste
Injection Wells at the West McArthur River Unit (WMRU) and Redoubt Unit (RU), Cook Inlet,
Alaska

U.S. Environmental Protection Agency, Region 10
Office of Enforcement and Compliance
Underground Injection Control (UIC) Program
Ground Water Protection Unit, OCE-127
1200 Sixth Avenue
Seattle, Washington 98101

September 7, 2006

Background

Forest Oil Corporation (FOREST) has submitted an Underground Injection Control (UIC) permit application for the operation of up to two (2) Class I non-hazardous industrial waste injection wells. The bottom hole well locations of the wells are offshore. One well is located on the offshore Osprey production platform (Redoubt Unit) and one well extends offshore from the onshore West McArthur River Unit (WMRU) facility in the Cook Inlet area, Alaska. These two wells are currently Class II disposal injectors that have been in service for many years. The Class I wells will primarily continue to inject produced water, well work-over and treatment fluids and treated sanitary wastewater. The initial application was submitted on August 25, 2006. EPA has prepared a draft UIC permit and earlier granted a "No underground sources of drinking water - USDW Ruling" (dated July 24, 2006) associated with the Tyonek disposal zones and the oil and gas reservoirs at this location.

Public Comment

Peer review comments are sought in developing the proposed permit and this fact sheet from the Alaska Department of Environmental Conservation (ADEC), the Alaska Oil and Gas Conservation Commission (AOGCC) and Cook Inlet Tribal Council. EPA is now requesting public comment on the draft permit. Persons wishing to comment on the proposed permit may do so by **October 10, 2006**. EPA will issue no separate public notice and may finalize the permit as drafted if no substantive comments are received by the close of the public comment period.

Regulatory Framework

The Underground Injection Control (UIC) program is authorized by Part C of the Safe Drinking Water Act for the principal purpose of protecting Underground Sources of Drinking Water (USDWs) from impacts by injection through wells. The UIC regulations broadly define USDWs (see 40 CFR 144.3) as any aquifer capable of supplying a public water system with water of less

than 10,000 milligrams per liter (mg/L) total dissolved solids (TDS). If injection does not occur above, into, or through a USDW, then less stringent injection well permit conditions may be imposed than would otherwise be required (see 40 CFR 144.16).

Primary responsibility for regulation of injection wells through the UIC program is split in Alaska between EPA and the Alaska Oil and Gas Conservation Commission (AOGCC). The AOGCC regulates Class II injection wells, which are defined as those wells used 1) to dispose of waste fluids brought to the surface from oil and gas production operations, 2) for enhanced recovery of oil and gas, or 3) for storage of hydrocarbons which are liquid at standard temperature and pressure (see 40 CFR 144.6). EPA directly regulates the other four classes of injection well in the State of Alaska. The UIC regulations allow Class II fluids to be disposed of into Class I or II injection wells. Class I fluids, however, may not be injected into Class II wells.

FOREST has requested that two existing Class II disposal wells be reclassified as Class I non-hazardous wells. The proposed Class I wells will primarily continue to inject produced water, well work-over and treatment fluids and treated sanitary wastewater, limited disposal of drill cuttings and muds, and other exempt fluids. Minor amounts of non-exempt, non-hazardous liquids, would also be disposed. As the RU and WMRU facilities approach end-of-life, fluids from vessel clean out and abandonment activities will also need to be disposed. On a remaining estimated 7-10 year field life basis, the approximately 297,000 barrels of Class I waste fluids would constitute a 0.359 % increase in the 8.27 million barrels of fluids already injected into the Tyonek disposal zones.

The RU and WMRU aquifers in the injection intervals in the existing disposal well WMRU 4D (between the Shale marker at 4855' MD based on the Pan Am West Foreland Unit Well No.2 Log to the base of the current disposal horizon at 6344' below sea level (BSL) based on the WMRU No. 4 Log) and the existing disposal well RU D1 (between the Shale marker at 5650' MD based on the RU D1 Log to the base of the current disposal horizon at 6343' BSL based on the Pan Am Redoubt Shoal St. 22064) are too saline (over 10,000 total dissolved solids) to serve as an underground source of drinking water (USDW).

Based upon a review of the information provided by FOREST, EPA had earlier issued a "no USDW" ruling that covers those portions of the aquifers in the injection intervals. Under these circumstances, the Director may authorize injection with less stringent requirements than would otherwise be required (see 40 CFR 144.16). EPA intends to grant several waivers requested by FOREST, which are described under the Geologic Setting and Injection Issues portion of this Fact Sheet.

EPA Permit and General Project Overview

EPA's 10-year term permit would allow FOREST to inject non-hazardous waste fluids such as, produced oil reservoir brine, production camp waste water, production well work-over fluids, well flushing (seawater), storm water and other wastes (that did not come up from down hole), and minor drill fluids assuming two redrills/platform. The permit would allow FOREST to inject all of the non-hazardous waste fluids generated at FOREST through the (life of the permit or) abandonment and decommissioning of the platform and facility.

The proposed permit limits injection to the naturally saline Tyonek formation in the RU and WMRU location.

FOREST operates the RU and WMRU which have produced oil since 2002 and 1993 respectively. The RU D1 well is located offshore on the Osprey Platform in 45 feet of water in the Cook Inlet (Sec. 14, T8N, R14W, Lat 60 deg 41 min 44 sec and Long 151 deg 40 min 15 sec). The WMRU D4 well is located onshore at the WMRU Facility (Sec 16, T8N, R14W, Lat 60 deg 46 min 57 sec and Long 151 deg 44 min 48 sec), in the Kenai Borough. The injection intervals are in the Tyonek Formation, a middle member of the Kenai Group of Miocene and Oligocene age (10-25 million years old). The Tyonek includes multiple hydrocarbon producing formations that are primarily the result of low relief sinuous anastomosing streams resulting in fluvial deposition in a slightly distal position. Sands are inter-dispersed with siltstone, coal and shales along with sandy shales and shaly sand sections with lower porosity and permeability. A major oil producing zone is the underlying Oligocene Hemlock Formation and combined current production rates are 2100 barrels of oil per day (bopd) and 3750 barrels of water per day (bwpd).

Water flooding has been employed for pressure maintenance. To date (thru 6/30/2006), RU D1 Class II disposal well has received 1.373 million barrels of fluids (mostly produced water and including 140,000 barrels of drilling mud, cuttings and flush water. To date (thru 6/30/2006), WMRU D1 Class II disposal well has received 6.894 million barrels of fluids (mostly produced water). Hemlock produced fluids presently consist of 64 % water cut and the fields have an estimated remaining economic life of 7-10 years.

Based on information provided by FOREST, over the next 7-10 years, Class I wastes will constitute 2.2% of the future injectant and 0.2% of the waste streams could be solids. The types of wastes and estimated volumes to be injected over the next 7-10 years at the RU and WMRU are as follows:

Disposal Maximum Volume Estimates (in barrels) by Major Category (7-10 years)

<u>Waste Source</u>	<u>WMRU</u> (Barrels)	<u>RU Osprey Platform</u> (Barrels)	
Camp waste water	12,000	25,000	
Produced Water	6,600,000	2,800,000	
Well work-overs/flowback	20,000	20,000	
Storm waters	30,000	30,000	
Drilling muds/cuttings*	30,000	30,000	
Drill Flush Water*	10,000	10,000	
Industrial Class I (non-haz)	100	100	
Total	~ 6,702,000	~ 2,915,000	Grand Total ~ 9,617,100 barrels

* Drilling contingency: Muds, slurry and flush waters included above assumes two to four redrills or two new wells per facility.

FOREST has not applied for a hazardous waste injection well permit. Therefore, any listed hazardous wastes would need to be collected, stored, and transported to a RCRA-approved

hazardous waste treatment or disposal facility. Those wastes which are hazardous only because of a characteristic (such as ignitability, corrosivity, toxicity, etc.) may be treated to remove that characteristic and then injected as a Class I non-hazardous waste fluid. The only radioactive substance which may be injected under the proposed permit is naturally occurring radioactive material (NORM) from sludge or pipe scale (a mineral precipitate formed during production), which can be injected into either Class II or Class I non-hazardous waste injection wells.

Geologic Setting and Injection Issues

The geologic setting at the RU and WMRU is very compatible for waste disposal via injection wells. Large volumes of Class II (produced water) have been successfully placed in the Tyonek formation sands for many years. The waste stream will contain very low solids content and the injection pressure will not approach the formation fracture gradient except in the rare event that drilling wastes are injected.

To date 1.373 million barrels (bbls) of Class II fluids (mostly produced water) has been injected in RU D1 well and 6.894 million bbls of Class II waste water has been injected in WMRU 4D well without any detectable leakage above the confining zone which lies on top of the injection zone.

Injection, Arresting and Confining Zones

The proposed injection, arresting and confining zones at RU and WMRU are composed of sedimentary strata of Tertiary age. These strata are assigned to the Tyonek formation.

The proposed injection intervals are individual Upper Tyonek formation sands that have good porosity (10-24 %) and good permeability (20-100 millidarcies). The injection zone of the RU D1 well has an approximate thickness of 2920 feet (between 5780 and 8700 feet), with upper containment provided by a 130 foot interval between 5650 and 5780 feet and lower containment provided by approximately 42 feet of tight shale and two coal stringers approximately 24 feet thick. Additional impervious zones are present compartmentalizing the sands between the upper and lower confining zones.

FOREST drilled the WMRU 4D as a short sidetrack (615' MD) from the existing WMRU 4 wellbore, for use as a Class II disposal well the injection zone of the WMRU 4D well has an approximate thickness of 600 feet (between 5708 and 6305 feet). Although the WMRU 4 well was not logged shallow enough to show the upper containment interval, correlation among offsetting wells shows a good barrier consisting of tight sands, shales and coals to be present. The interval between 4855 and 4935 feet is viewed as the upper confining zone while the lower part between 4935 and 5040 feet is viewed as an arresting zone and includes 105' MD of mostly shale and coal (based on Pan Am West Foreland Unit No. 2 offset well log). Containment below the disposal zone will be provided by coals and shales lying between 6258 and 6344' as shown on the WMRU 4 open hole log. As stated earlier, these zones have been used for Class II disposal injection for several years with no reported leakage problems.

Structure

The WMRU is on the southern portion of a south plunging faulted anticline feature that strikes north-northeast to south-southwest. Located in the southernmost fault block, it is bounded by a graben to the north by the trapping fault and larger down-to-the-south normal fault. The formation dips to the southwest at approximately six degrees. The fault block is bounded to the west by a small reverse fault striking north-south with a small displacement and may represent more of a flexure than a true rupture. Disposal is into the hanging wall fault block. While local faults are present as shown on the cross sections and structure maps, these features are all sealing, as evidenced by the trapping of hydrocarbons and lack of observed leakage to date.

The RU disposal well is located basinward and structurally lower than the WMRU in a footwall block formed by a north-south trending reverse fault thrusting to the west. The fault block is bounded to the southeast by a second high angle reverse fault. The formation dips to the south-southeast by approximately five degrees.

Reservoir Rock Properties

Porosity and permeability values for the different lithologies (obtained from wireline logs, core analysis and pressure transient analysis) are shown in the following table.

	<u>Effective Porosity (%)</u>	<u>Permeability (millidarcies)</u>
Sand	10-24	20-100
Silt	2-6	0.1-1
Shale	0	0.0001-0.01
Coals	0.05	5

Fracture gradient (FG) obtained from the deeper Hemlock formation over the period 1974-1987 indicates an average FG of 0.93 pounds per square inch/foot (psi/foot) and agrees with data collected and still used during drilling to test casing shoes after cementing operations at much shallower depths. The reservoir pressure was between 4000-4500 pounds per square inch (psi) at the time that stimulation work was being done.

Subsurface Aquifers/USDWs/Aquifer Exemption

A USDW is defined as an aquifer which is currently serving as a source of potable water or which, by virtue of its potential productivity and natural water quality (i.e., less than 10,000 milligrams per liter of total dissolved solids or TDS), could serve as a public water supply.

The Federal regulations at 40 CFR 144.7, 146.4 and 147 (b) (2) allow an aquifer(s) to be exempted from protection as a USDW provided it meets several criteria. On July 24, 2006, the EPA ruled that there are no USDW's within ½ mile radius of WMRU 4D wellbore between the depth of 4855 feet MD and 6344 feet MD and within ½ mile radius of RU D1 wellbore between 5650 feet MD and 6343 feet MD.

The WMRU Field currently has a Class II aquifer exemption approved by the Alaska Oil and

Gas Conservation Commission (AOGCC Injection Order #7- effective April 19, 1993 and Injection Order #16- effective September 3, 1998) for the portion of aquifers beneath WMRU below 4000 feet subsea. The RU Field currently has a Class II aquifer exemption approved by the Alaska Oil and Gas Conservation Commission (AOGCC Injection Order #7- effective April 19, 1993) for the portion of aquifers beneath RU below 3749 feet MD (3650 feet True Vertical Depth) subsea.

FOREST submitted petro-physical and water sample data to provide support and obtain from EPA a “no USDW” ruling for aquifers within ½ mile radius of RU D1 borehole between 5650' MD based on the RU D1 Log to 6343' BSL based on the Pan Am Redoubt Shoal St. 22064 and aquifers within ½ mile radius of WMRU 4D borehole between the Shale marker at 4855"MD based on the Pan Am West Foreland Unit Well No.2 Log to 6344' below sea level (BSL) based on the WMRU No. 4 Log. The ruling dated July 24, 2006 applies to the current WMRU 4D and RU D1 wells.

As a result of the “no USDW” ruling for Class I injection and the existing Class II exemption, EPA intends to grant four (4) waivers of UIC regulatory program requirements as listed below:

- (1) Compatibility of Formation and Injectate (40 CFR 146.12 (e) and 146.14 (a) (8):
Based upon the applicability of past injectability studies and injection practices at the WMRU and RU, Cook Inlet, EPA intends to waive the above two requirements for any additional sampling and characterization of formation fluids and injection rock matrix in order to determine whether or not they are compatible with the proposed injectate.
- (2) Injection Zone Fracturing (40 CFR 146.13 (a) :
Class I injection wells are prohibited from injecting at pressures that would initiate new fractures or propagate existing fractures within the injection zone. Based on the fracture modeling data submitted by FOREST which indicated that the injection fluids will be contained within the proposed injection zone, the draft permit would waive this prohibition, and would instead allow hydraulic fracturing so long as new fractures are not initiated nor existing ones propagated within the upper confining zone. Injection in Well RU D1 will be limited to the existing Class II injection zone interval (current perforations between 8216 and 8450 feet) and the secondary disposal interval between 7650 and 7900 feet (if needed at a later date since the existing packer is set shallow at 7620 feet MD). Injection in Well WMRU 4D will also be limited to the existing Class II injection interval (current perforations between 5708 and 6130 feet) in the Tyonek formation.
- (3) Ambient Monitoring Above the Confining Zone (40 CFR 146.13 (b) :
EPA intends to waive the requirement to monitor the strata overlying the confining zone for fluid movement since the portion of aquifers at the WMRU 4D and RU D1 (referenced above) do not qualify as USDWs (portion of aquifers are too naturally saline).

Summary of Proposed Action and Permit Conditions

EPA has primary enforcement authority in Alaska for the 1422 portion of the UIC program (authorized by Part C of the Safe Drinking Water Act), which includes the regulation of Class I injection wells. Class I wells are used to inject waste fluids for safe disposal beneath any existing USDWs. EPA proposes to grant a Class I UIC permit to FOREST in accordance with Title 40 CFR 144.33 for two (2) Class I non-hazardous waste injection wells at the WMRU and RU, Cook Inlet, Alaska. FOREST is authorized to substitute alternate candidate wells in the event any of the above two candidate Class I wells fail to demonstrate mechanical integrity. However, FOREST shall identify the substitute candidate Class I well(s) and give a 30-day written notice with well data prior to conducting the mechanical integrity test (MIT) on the substitute candidate well(s). Again, no Class I well shall be placed on injection prior to successfully demonstrating its mechanical integrity and approval from EPA.

EPA considered all of the available disposal options, and concludes that underground injection is the best disposal method for the oilfield produced waters and non-hazardous liquid and solid wastes to be disposed at the WMRU and RU facilities.

The draft permit contains general legal provisions common to EPA permits, specific technical requirements that apply to all Class I injection wells, and particular technical, monitoring and reporting requirements for the proposed injection operations at the WMRU and RU fields, Cook Inlet, Alaska.

The EPA contact for further information is Thor Cutler at (206) 553-1673 or cutler.thor@epa.gov